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The Impact of Quality Control Tools Application on Supply Chain Management: A Case of Wossi Garment Factory

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Abstract

The purpose of this paper is to investigate quality control and supply chain management practice in the case company (Wossi Garment Factory) and apply the statistical quality control tools to solve the process and product quality problems in shirt manufacturing and increase the competitiveness of the company. The case study was done using both qualitative and quantitative approaches which could be said mixed approach. First of all, data collection has been conducted by actual presence in the case company. The data were collected using the check sheet. The team has collected the two months data from the case company. After adequate statistical data was collected, the team had used Microsoft excel and excel add on software to analyze the data using statistical quality control tools. The level of quality expectation of the products within the international customers are high, however the case company, the quality control system is not as strong as it is supposed to be. The company is not using statistical quality control tools except check sheet. Because of this, there is significant amount of rejection of products and has resulted on low economic benefit. The products with defects do not qualify for international market rather whenever there is defect on product; it is pushed to local market which has impact on supply chain performance generally. The case study has shown that, the quality of shirt could be improved to the extent of making the defect zero if the statistical quality control tools are applied properly. The case study team has shown the methodology and the sequence of the application of the statistical quality control tools and basically systematic application of DMAIC following with check sheet, process flow diagram, fishbone, Pareto Chart, histogram, control limits and process capability enhancement could bring significant quality improvement in the case company. This paper showed the direct relationship of statistical quality control tools application and supply chain management. Mathematical modeling of impact of quality control over the supply chain performance and cost benefit analysis has been used as major methodology and result discussions and conclusions are drown and recommendation is also forwarded.

Keywords: Garment industry; SQC; SPC; Quality; Supply chain network; Supply chain design

Introduction

The Seven Basic Tools of Quality are the designation given to a fixed set of graphical techniques identified as being most helpful in troubleshooting issues related to quality as per the American Society for Quality. In business, engineering, and manufacturing, quality has a pragmatic interpretation as the non-inferiority or superiority of something; it's also defined as being suitable for its intended purpose (fitness for purpose) while satisfying customer expectations.

The garment manufacturing industry is a large and most export-oriented field in developing countries. This manufacturing sector is very much important in terms of output, export and employment creations. Wossi Garment Factory is one of the medium level companies operating in the global supply chain ecosystem. The company produces export oriented products; however, the products which do not fulfil quality requirement of international market are pushed to local market. The purpose of this case study is to reduce or eliminate quality problems on the product of the company using statistical quality control tools and hence study the impact of quality control application on the supply chain performance of the company.

Background and Statement of Problem

The case company is export oriented garment industry producing different varieties of the garments. As the group has tried to see four months production trend, the maximum share of the products is shirt (37.6%) as shown on the Table 1 below. The quality problem in this product will have high Economic impact for the company as it has highest product share. This is the reason why the paper focuses on shirt product among company products.

S/N	Types of product	Month 1	Month 2	Month 3	Month 4	Total production in each product type	percent
1	Shirt	10218	10842	8242	10478	39780	37.6
2	Gown	5694	5486	4966	5122	21268	20.1
3	Coat	4914	5018	3978	2626	16536	15.6
4	Suit	2548	1794	2314	1742	8398	7.9
5	Trouser	3796	2938	3094	1898	11726	11.1
6	Dress	1170	1898	2652	2262	7982	7.6
Total		28340	27976	25246	24128	105690	

Note: *Working days: six days in the week and 26 days in the* monts.

Table 1: Four months production data of the six products.

Therefore from the above data shirt production is the highest production percentage when we compare with other six production types that are why this case study focuses on shirt production in wossi garment industry. The company doesn't use statically quality control tools except the check sheet. This study focuses on applying the other statistical tools in order to improve the quality of the specific products.

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The quality problems (defects) include: Sewing defects (skip stitch, broken stitch, side seam uneven, wavy stitch are some of the sewing defects.), Part joining defects, Button attachment defects, Embroidery defects, Finishing defects (Fabric defects, Loose sewing threads, Misaligned button defects, Misaligned buttons holes defects, missing button defects, unfinished buttonhole defects, inappropriate trimming defects). 8.6% of shirt products are pushed to the local market because of quality problems or defects.

Assessment of quality challenges over supply chain: A supply chain, in simple terms, is a system of organizations, people, activities, information, and resources involved in moving a product or service from supplier to customer. Supply chain activities involve the transformation of natural resources, raw materials, and components into a finished product that is delivered to the end customer.

When we see the trend of the case company, if the product doesn't fulfil the quality standard required by the international market which is potential product importers, such as USA, Germany, Ghana and Senegal then, the product will be supplied to the local market. This has big implications when it comes to what company loses and what the country loses in terms of foreign currency (Figure 1).

During our company assessment, we have come to understand that the case study company supply chain management has direct linkages with quality management. If the product fulfils international market product quality standard already defined by the importers, the products could be exported but if the products have defects then the company pushes it to the local market.

Delimitation of the Study

The scope of the case study is delimited to the single product, which is export standard gent's shirt, among different products. The study is basically focussing on the investigation of the quality tool application with perspective of its impact on the supply chain management. The study has focused supply chain from manufacturing to the customer and didn't include the supplier for the sack of manageability.

Literature Review

Quality improvement tools

A large number of studies have determined major quality improvement tools. According to, solving problems related to quality is not sufficiently addressed without applying the specific tools that can help make the right quality decisions. The paper of the aforementioned three researchers discusses the quality and productivity improvement in a manufacturing enterprise through practical study and application of SQC tools. SQC tools can be used by operators to monitor their part of production or service process for the purpose of making improvements Mashiur [1].

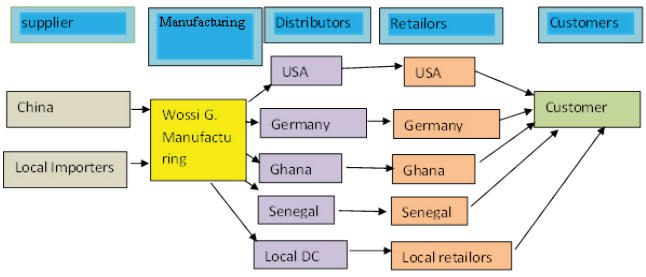

Figure 1: Supply Chain Process of the case company.

Fabric defects

Most of the products in the garment industry have a short lifespan. With new products, new defects arise. Even after knowing the products in & out, it is very hard to keep defects from finding their way to the finished product [2]. According to Kalayu the four critical fabric defects (Needle line, Hole, Yarn variation and Lycra jump) are achieved and these fabric defects need to be corrected to minimize the rejection rate by 80% [3].

Garment defects

According to Dengzler, the SPC methods such as check sheet, Pareto analysis, cause-effect diagram and control chart were used to analyse sewing defects [4]. The reasons of the defects are analysed with the cause-effect diagram for the operation which has the highest sewing defect rate. Sampling based statistical quality control system is proposed in finishing section to eliminate 100% inspection by sampling based inspection Mohibul [5].

Supply chain management

SCM is the management of a network of interconnected businesses involved in the ultimate provision of product and service packages required by end customers [6]. SCM spans all movement and storage of raw materials, work-in-process inventory, and finished goods from point of origin to point of consumption (supply chain).

Supply chain management and quality

As organizations link quality management (QM) or total quality management (TQM) to supply chain management (SCM) and extend their vision beyond their own firms into the supply chain to manage quality, most current research has referred to such integration and co-ordination of the two concepts as supply chain quality management (SCQM) to highlight the paramount importance of quality to a supply chain's long-term success (e.g. Ross 1997, Evan and Dean 2000, Robinson and Malhorta 2005, Foster 2008, Foster and Ogden 2008). As cited in Ebrahim et al. it is particularly the case for those firms which operate globally, not least because, first, their competitive advantage position in one country is significantly affected by their position in other countries or vice versa, and more specifically and second, to compete on quality in the global market firms must ensure that their suppliers are on the leading edge in quality and regarded as high performers [7-10]. The cost increase results from rework in manufacturing and poor Quality of products delivered because the SCM negotiations focused on price and not quality. This problem is widespread for both products and services, e.g. parts, software providers, transportation, etc. Historical data and experts claim that quality impacts 30-70 percent of the final cost of the product [11].

Research Methodology

The case study was done using both qualitative and quantitative approaches which could be said mixed approach. First of all, data collection has been conducted by actual presence in the case company. The data were collected using the check sheet. The team has collected the two months data from the case company. Besides, the team has observed the case company thoroughly and conducted unstructured in-depth interview with the quality personnel, marketing, purchasing staffs, operators and the company owner, general manager, to understand maximum about the company and the specific process activities in the entire operation and also to understand what statistical quality control tools are applied in the company so far [12-15].

After adequate statistical data was collected, the team had used Microsoft excel and excel add on software to analyze the data using statistical quality control tools. The impact of the quality over supply chain was indicated using mathematical model.

Generally, process study, identifying critical failures through company gap assessment and analysis, understanding the whole supply chain management through data collection using secondary data and primary data by using specifically unstructured in depth interview, analysis and result discussion were the measure steps followed as methodology [15-20].

Result Analysis and Discussion

During the unstructured in-depth interview and focus group discussion, respondents from the case company have disclosed that the culture of supply chain planning is not well practiced. It is rather practiced using traditional approach; something unplanned. The raw materials are purchased from the local distributors in Merkato, which is one of the biggest market in Addis Ababa, or from China directly.

Some of the key challenges in the supply chain management are:

No planning of proper supply chain management; the case company manages the supply chain by traditional approach, the case company is not getting advise of professionals in supply chain management, lack of foreign currency and credit, very low practice of statistical quality control tools to improve product quality for ultimate satisfaction of customers.

Data collection, SQC tool implementation and analysis with perspective of its impact over supply chain

The case company is using only check sheet among the statistical quality control tools. By using check sheet, we have collected two months data from the industry. As our investigation, the major defects in the shirt manufacturing process are sewing defects, Part joining defects, Embroidery defects, finishing defects as shown below on the Table 2.

As the data on the table above shows, out of the two months' total shirt production, which is 18,720, 1,603 are defective which 8.6% of the total production is. To identify the frequency of occurrence of each defect, we have used Pareto chart (Table 3).

The Pareto chart in Figure 2 shows that the most frequent defect is sewing defect, which takes 30.3 % of defects. Therefore the team decided to analyze sewing defects further by collecting data separately in each sewing defect types. Further data again are collected using the check sheet as shown below. According to the data collected, the sewing defect types are Skip stitch, Broken stitch, Side seam uneven and Wavy stitch (Table 4).

After the data is collected on the sewing defects such as Skip stitch, broken stitch, Side seam uneven and Wavy stitch, Pareto chart was done to identify the most frequently occurring sewing defect type as shown Table 5.

As shown in Figure 3 of Pareto chart, the most frequent sewing defect type is Wavy stitch. However, the most savior defect is the second frequent defect which is Side seam stitch unevenness according to the qualitative data that we gathered from the quality and marketing personnel. Significant Side seam unevenness is serious defect that results on automatic rejection of product.

Both wavy stitch and side seam unevenness need to be solved so that the quality of shirt could be improved. Therefore root cause analysis has been carried out for both wavy stitch and side seam unevenness using fishbone as shown in Figure 4 and the solution is also set for respective root causes (Figure 4).

S/n	Defects	Week	Days of a week					
			Mon	Tue	Wed	Thurs	Fri	Sat
1	Sewing defects	1	7	8	8	10	11	12
		2	6	8	7	9	9	11
		3	7	6	8	9	11	11
		4	11	9	12	8	7	7
		5	10	13	15	17	13	10
		6	9	15	11	13	10	9
		7	14	10	12	17	9	8
		8	8	11	12	9	7	12
2	Part joining defects	1	3	4	4	6	6	7
		2	4	3	7	6	5	4
		3	5	5	7	6	5	6
		4	3	5	4	7	6	7
		5	7	5	5	8	11	10
		6	10	7	11	5	6	10
		7	2	7	9	8	10	9
		8	8	11	7	3	10	10
3	Button attachment defects	1	4	3	5	4	3	4
		2	5	6	5	4	3	5
		3	4	3	4	5	3	5
		4	5	4	6	6	5	5
		5	5	7	6	9	10	7
		6	5	7	7	9	7	6
		7	4	7	5	6	9	7
		8	11	8	5	9	6	8
4	Embroidery defects	1	3	2	2	5	4	4
		2	0	2	4	3	1	3
		3	2	3	3	2	2	3
		4	1	3	5	2	4	2
		5	4	3	6	2	4	4
		6	5	6	5	6	4	3
		7	0	3	5	4	1	7
		8	4	4	5	7	6	5
5	Finishing defects	1	4	5	8	9	8	6
		2	5	6	7	6	7	6
		3	6	6	5	7	6	8
		4	6	7	5	6	7	6
		5	9	10	8	9	7	10
		6	7	8	7	10	7	11
		7	7	6	8	11	8	8
		8	9	10	9	11	8	9

Table 2: Defects collected using check sheet.

S/n	Defects	Total	Percentage for each	Percentage cumulative
1	Sewing defect	486	30.3	30.3
2	Finishing defect	359	22.4	52.7
3	Part joining defect	314	19.6	72.3
4	Button attachment defect	276	17.2	89.5
5	Embroidery defect	168	10.5	100

Table 3: Shirt defect data for Pareto chart.

The detail analysis has been done on the root causes and based on the interview with the quality head and the operators, the most savior and frequent root cause of the wavy stitch defect is operator skill gap, carelessness and thread tension. Therefore, we have set the solutions for the root causes as follows:

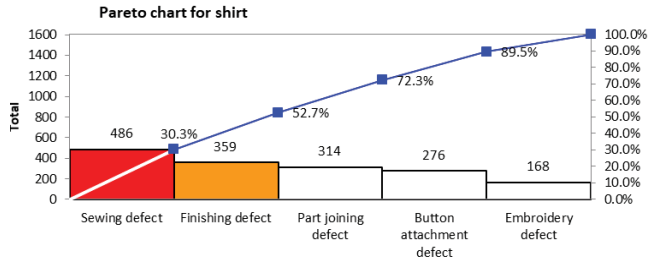

Figure 2: Pareto analysis for sewing defects.

S/n	Defects	Week	Days					
			Mon	Tue	Wed	Thurs	Fri	Sat
1	Skip stitch	1	0	1	0	1	0	1
		2	0	1	2	0	1	0
		3	1	0	1	1	0	0
		4	0	2	1	0	0	2
		5	1	0	1	1	0	1
		6	0	1	1	0	2	0
		7	1	0	1	0	1	0
		8	0	2	1	1	0	1
2	Broken stitch	1	1	0	2	0	0	4
		2	2	3	1	1	2	2
		3	0	1	2	0	3	0
		4	2	1	4	1	3	3
		5	1	2	3	1	2	4
		6	0	5	4	3	0	4
		7	2	0	4	0	2	2
		8	0	4	0	7	0	2
3	Side seam uneven	1	4	3	4	2	3	4
		2	0	2	4	4	3	2
		3	2	4	4	2	3	4
		4	2	4	0	5	2	3
		5	3	4	3	4	6	5
		6	2	3	3	4	3	3
		7	4	4	5	3	6	5
		8	4	4	2	5	6	5
4	Wavy stitch	1	3	4	3	5	6	4
		2	6	5	4	7	5	3
		3	2	3	2	4	5	3
		4	1	3	4	2	3	2
		5	5	6	4	6	5	4
		6	3	5	6	5	4	3
		7	3	3	5	4	1	7
		8	5	4	4	6	7	5

Table 4: Sewing defects.

S/n	Defects	Total	Percentage for each	Percentage cumulative
1	Wavy stitch	199	41	41
2	Side seam stitch uneven	166	34.1	75.1
3	Broken stitch	90	18.5	93.6
4	Skip stitch	31	6.4	100

Table 5: Data of sewing defects for Pareto chart.

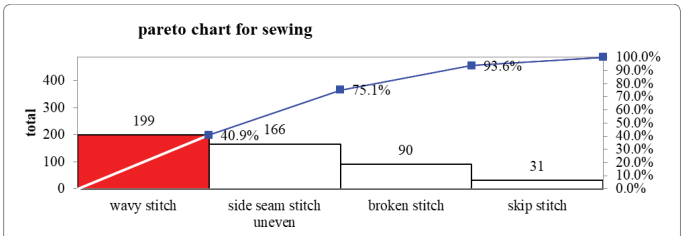

Figure 3: Pareto chart.

Identify operators with skill gap and providing continuous skills upgrading training, Incentivize and penalize the best performers and careless operators respectively, check the set of the machine daily before straining operation to make sure the tread tension is proper (Figure 5).

The detail analysis has been done on the root causes and based on the interview with the quality head and the operators, the root cause of the side seam unevenness defect is operator skill gap, carelessness and lack of process capability control limit. Therefore, we have set the solutions for the root causes as follows: Identify operators with skill gap and providing continuous skills upgrading training, Incentivize and penalize the best performers and careless operators respectively, determine control limit based on the customer specification and enhance process capability.

As we are able to understand the most part of the side unevenness that caused for most of product rejection and being out of specification (3.5 - 4.5 cm), the unevenness on placket width is the most serious.

Therefore, further data has been collected on the width of the shirt placket to understand the process control and capability. The Table 6 shows that the data collected on the variability of the placket width in centimetre.

Histogram has been developed using the software and applied to see the distribution of the data. The histogram below is skewed and shows that the distribution of the width of the placket is not normal (Figure 6).

Control chart is developed using the software to check whether the process is statistically in control or out of control. As it is shown Figure 7 on X and R chart, the process was statistically out of control. This shows that there are assignable problems to be solved which are basically investigated using fishbone diagram Figures 4 and 5.

Considering that assignable problems will be solved using the solution suggested above following the fish bone analysis technique, we have removed those statistically out of control points and constructed another control limit using the excel add on software as shown below (Figures 8-10 and Table 7).

The Control charts above show that the data is in statistical control but it does not mean that the process is capable against specification. The specification is 3.5 with LSL and 4.5 with USL where by the target value is 4; all dimensions in cm. Therefore process capability checking has been done using 115 measurements which are in statistically control. Using the data on the table below, Histogram has been developed using the software and the Cp, Cpk, and Cpm analysis has been conducted whether the process is capable or not.

On the histogram Figure 11, we see the value of Cp is greater than Cpk and hence the process if running off center. The histogram is skewed by 0.37. Cp is greater than Cpm and this shows that there are nonconforming units of products and the process is incapable.

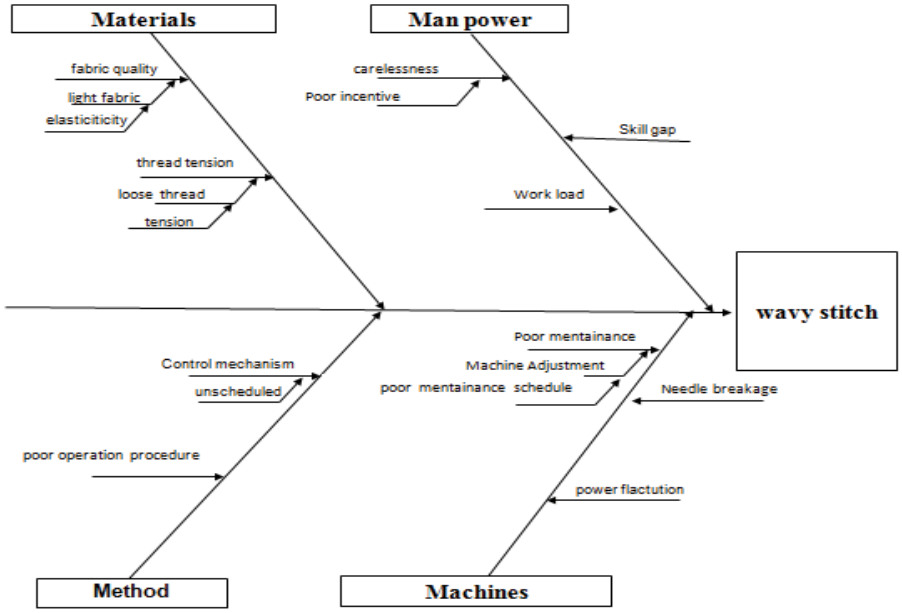

Figure 4: Fishbone for wavy stitch.

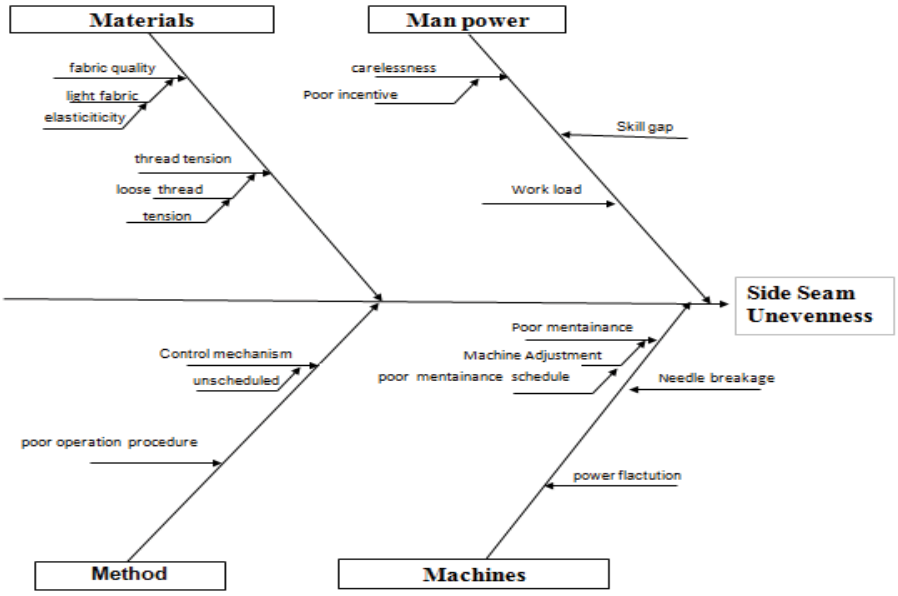

Figure 5: Fishbone for side seam unevenness.

By removing those measurements out of specification limits with Consideration that the assignable problems which leads to the process incapability could be solved by the solutions suggested in the fishbone analysis above will be solved, the table below containing 65 measurements has been used to construct final control limit and the process capability has been also checked using the histogram before construction of control limit (Table 8).

The histogram Figure 12 shows that the process is capable as the Cp is less than the Cpm and the value of Cp and Cpk is equal which shows the skewness is almost zero and the process is running at the centre.

Totally 65 measurements with in LSL and USL have been considered to set the control limit for the process capability to be to the required level (Figure 13).

Modelling of the impact of the quality over supply chain

The case company has been disadvantaged of weak practices of statistical quality control application. The higher quality of the products, the easier the company penetrates international market and it has big impact on the company's profit margin and gaining of foreign currency.

Sample strata	1	2	3	4	5	x mean	R
1	3.98	4.11	3.76	4.25	3.6	3.94	0.65
2	4.89	4.5	4.89	3.76	4.5	4.508	1.13
3	4.3	3.5	4.46	3.8	4.3	4.072	0.96
4	3.98	4.1	4.44	3.97	4.23	4.144	0.47
5	3.87	3.98	4	3.87	3.98	3.94	0.13
6	4.23	4.11	3.76	4.45	3.96	4.102	0.69
7	4	3.89	3.75	3.35	3.45	3.688	0.65
8	4.87	4.78	4.35	4.98	4.67	4.73	0.63
9	4	3.87	3.89	4.5	3.67	3.986	0.83
10	3.98	4.2	3.6	4	3.45	3.846	0.75
11	4.5	3.89	3.98	4.02	3.46	3.97	1.04
12	4.45	3.58	4	3.6	4.05	3.936	0.87
13	3.76	4.11	3.76	4.34	4.32	4.058	0.58
14	3.98	4.35	3.76	4.56	3.98	4.126	0.8
15	4.6	3.98	3.87	4.35	3.6	4.08	1
16	4.5	4.03	4.95	4	4.78	4.452	0.95
17	3.98	4.11	3.97	4.25	4.3	4.122	0.33
18	3.99	4.05	3.97	3.67	3.76	3.888	0.38
19	3.96	4.76	3.78	4	3.97	4.094	0.98
20	3.98	4	3.8	4.25	3.5	3.906	0.75
21	3.98	3.5	4	3.98	4.02	3.896	0.52
22	4.4	4.02	3.5	3.98	4.3	4.04	0.9
23	3.98	4	3.69	4.5	3.4	3.914	1.1
24	4.5	3.98	3.76	4	4.7	4.188	0.94
25	3.96	4	4.76	4.25	4.03	4.2	0.8
Total					Mean	4.07304	0.7532

Table 6: Data on variability of width of the packet.

The impact of the quality over the supply chain and the benefit of company is mathematically modelled as shown below.

Let; Q is annual production of shirt, D is annual products with defects, UC1 is factory unit price for products without defect (which could fit for international market), UC2 is factory unit price for products with defect (which could not fit for international market but local market).

Therefore, the impact could be seen in terms of supply chain network shift when the product quality is to standard and not to standard because when the product has defect, the product market could be only local market and this is major shift in terms of supply chain network.

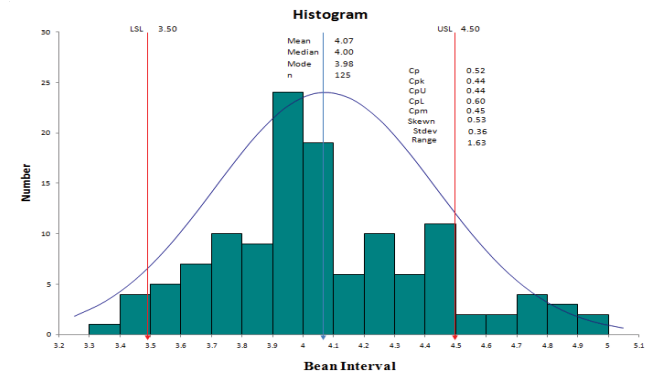

Figure 6: Histogram on placket width.

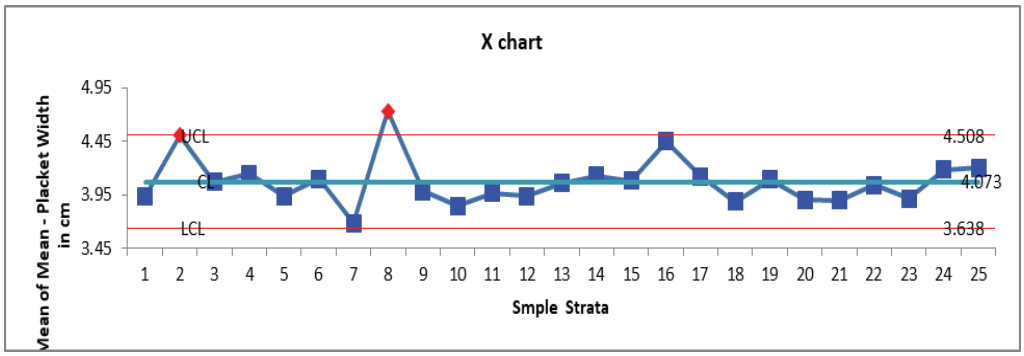

Figure 7: X charts before measurements with assignable problems are not removed.

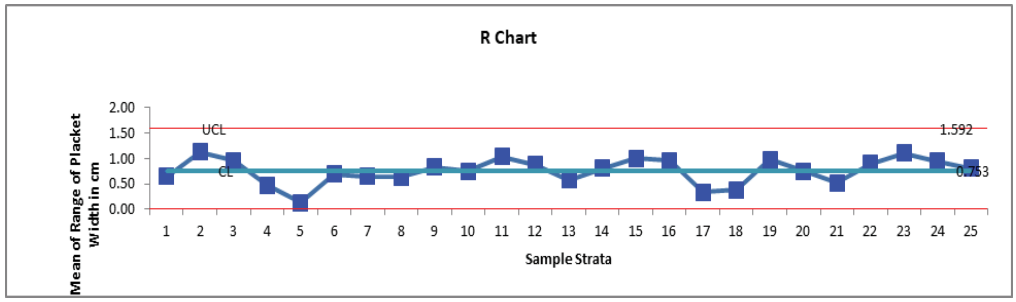

Figure 8: R-charts before measurements with assignable problems are not removed.

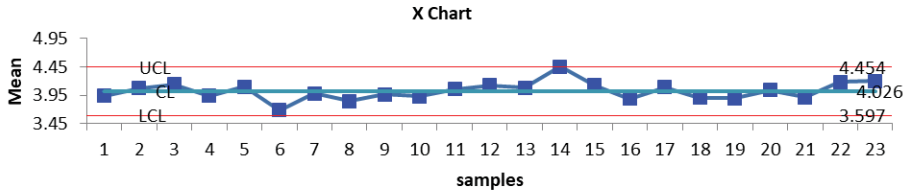

Figure 9: X Chart after the statistically out of control measurement is removed.

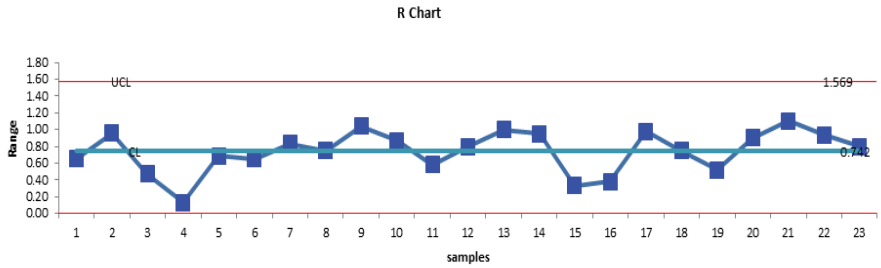

Figure 10: R Chart after the statistically out of control measurement is removed.

samples	1	2	3	4	5
1	3.98	4.11	3.76	4.25	3.6
2	4.3	3.5	4.46	3.8	4.3
3	3.98	4.1	4.44	3.97	4.23
4	3.87	3.98	4	3.87	3.98
5	4.23	4.11	3.76	4.45	3.96
6	4	3.89	3.75	3.35	3.45
7	4	3.87	3.89	4.5	3.67
8	3.98	4.2	3.6	4	3.45
9	4.5	3.89	3.98	4.02	3.46
10	4.45	3.58	4	3.6	4.05
11	3.76	4.11	3.76	4.34	4.32
12	3.98	4.35	3.76	4.56	3.98
13	4.6	3.98	3.87	4.35	3.6
14	4.5	4.03	4.95	4	4.78
15	3.98	4.11	3.97	4.25	4.3
16	3.99	4.05	3.97	3.67	3.76
17	3.96	4.76	3.78	4	3.97
18	3.98	4	3.8	4.25	3.5
19	3.98	3.5	4	3.98	4.02
20	4.4	4.02	3.5	3.98	4.3
21	3.98	4	3.69	4.5	3.4
22	4.5	3.98	3.76	4	4.7
23	3.96	4	4.76	4.25	4.03

Table 7: Measurement of placket width after the statistically out of control measurement is removed.

From the cost benefit perspective, it is shown mathematically as follows:

Taking the 8.6% defect which of course the case company has been facing, the amount of the product which could go for local market is, 8.6% * Q = annually such amount of product goes to local market. If it would have gone to international market with proper quality control mechanism, the cost difference could be given as follows besides the foreign currency advantage.

$(8.6\%^{*} Q^{*} UC1) - (8.6\%^{*} Q^{*} UC_{2})$

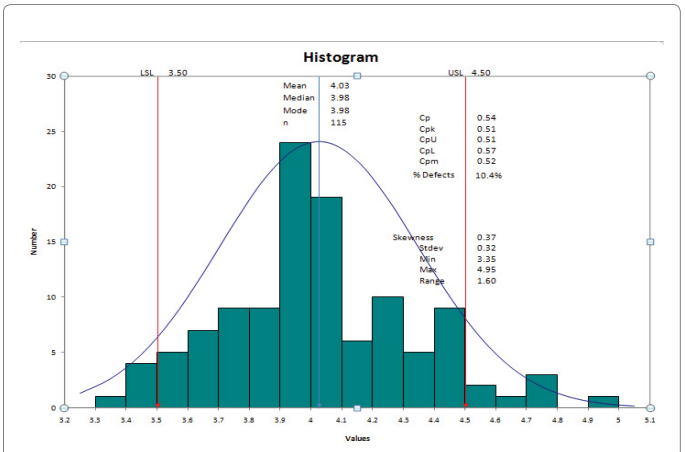

Figure 11: Histogram after the statistically out of control measurement is removed.

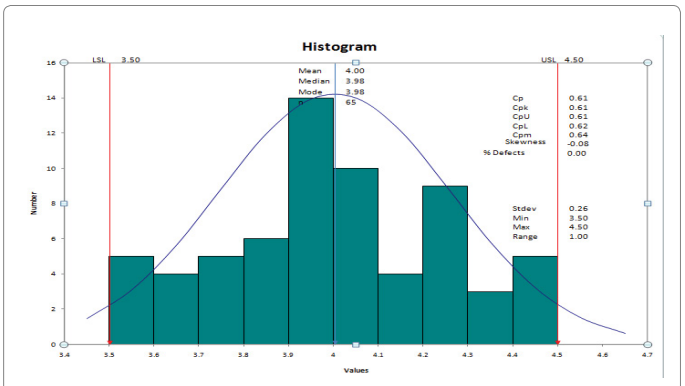

Figure 12: Histogram developed using measurements with in specification limits.

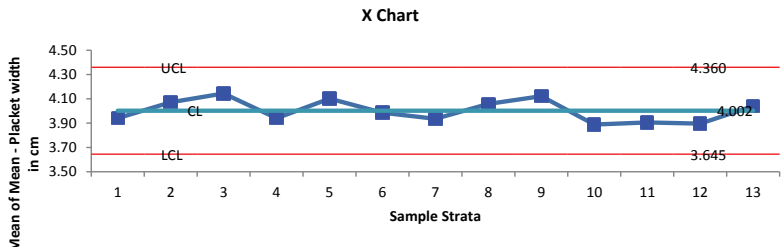

Figure 13: Control Chart after the process capability problems are solved.

Samples	1	2	3	4	5
1	3.98	4.11	3.76	4.25	3.6
2	4.3	3.5	4.46	3.8	4.3
3	3.98	4.1	4.44	3.97	4.23
4	3.87	3.98	4	3.87	3.98
5	4.23	4.11	3.76	4.45	3.96
6	4	3.87	3.89	4.5	3.67
7	4.45	3.58	4	3.6	4.05
8	3.76	4.11	3.76	4.34	4.32
9	3.98	4.11	3.97	4.25	4.3
10	3.99	4.05	3.97	3.67	3.76
11	3.98	4	3.8	4.25	3.5
12	3.98	3.5	4	3.98	4.02
13	4.4	4.02	3.5	3.98	4.3

Table 8: Measurement of Placket width with in specification limit.

Conclusion

It has been able to see the practices of application of statistical quality control tools and the supply chain management process with perspective of impact of former on the later in the case company. The case company is not following scientific approach of quality control to the level that it is supposed to be although the management is keen about improving the quality. The only statistical quality control tool in use is the check sheet but the rest are not in use. The case study has shown that, the quality of shirt could be improved to the extent of making the defect zero if the statistical quality control tools are applied properly. The case study team has shown the methodology and the sequence of the application of the statistical quality control tools and basically systematic application of DMAIC following with check sheet, process flow diagram, fishbone, Pareto Chart, histogram, control limits and process capability enhancement could bring significant quality improvement in the case company.

The study has shown that application of quality control tools improves the quality of materials flowing in the supply chain network. As a result the ultimate beneficiary of the supply chain, the customer, will get satisfaction and this has implication on the companies supply chain network expansion because as it is getting more customer satisfaction, the market expands in the international level (global supply chain network). As there is increase on the volume of sales on global market, it is not only the company who will benefit from such extended supply chain network but also the country will benefit getting additional foreign currency. Therefore application of SQC tools will result general on the improved quality of material flow and as the better the quality of material to flow, the better the satisfaction of the customer in the supply chain will be; given the other factors remain constant.

Recommendation

Based on the conclusion of the case study, the group has forwarded the following recommendations:

- The case company needs to be provide capacity building training for the quality personnel on the statistical quality control tools and their application to improve quality and also the impact of quality over supply chain improvement and customer satisfaction.
- The case company need to apply SQC tools such as process flow, fishbone, Pareto chart, histogram, control charts in addition to check sheet to improve the quality of product for ultimate satisfaction of customers
- Major root causes of quality problems and reasons for major challenges encountering related to supply chain are workers' skills gap, carelessness and material quality (tread) and hence skills gap training, incentives and quality materials need to be used.
- Proper supply chain management has to be in place and need to be well practiced. Supply chain planning has to be highly interlinked with the quality improvement of the product quality and process capability.

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